

# Abundance and Run Timing of Dolly Varden in the Kanektok River, 2002 – 2005.

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## ***Abundance and Run Timing of Dolly Varden in the Kanektok River, 2002 – 2005.***

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### **Abstract**

During the summers of 2002 through 2005 we estimated the annual passage of mature, prespawning Dolly Varden *Salvelinus malma* at the Kanektok River weir. We captured Dolly Varden to collect biological data and determine maturity between July and mid-August each year. Prespawners accounted for 55.0% to 98.5% of the sample. During the four year effort, an estimated 8,709 (SE = 588.1; 2002), 5,815 (SE = 517.8; 2003), 7,130 (SE = 158.0; 2004), and 9,073 (SE = 106.1; 2005) prespawning Dolly Varden passed upstream of the weir.

### **Introduction**

Dolly Varden are important to the subsistence fishery harvest from the Kanektok River (Wolfe et al. 1984; Willard Church, Native Village of Kwinhagak Natural Resource Department, personal communication). Quantitative information concerning the subsistence harvest of Dolly Varden in the Kanektok River is sparse, but they are likely harvested in such quantities to match or exceed the harvest of salmon by weight (Wolfe et al. 1984). The Alaska Community Profile Database (ADCED 2003) reported a harvest of over 24,247 char by residents of Quinhagak in 1984.

The Alaska Department of Fish and Game's (Department) statewide sport fish survey reports that sport catch of char (Dolly Varden and Arctic char) in the entire Kanektok River drainage has averaged 22,150 fish from 1995 to 1999 (Dunaway and Sonnichsen 2001). Sport harvest of these fish is small, ranging from 3-11% of the catch, and has averaged 421 fish during the same period. Angler effort averaged 7,329 angler days annually during this five-year period.

Subsistence and sport fishers have expressed concerns regarding declines in abundance and size of char in other systems within Togiak National Wildlife Refuge (USFWS 1990 and 1991). Similar concerns for char populations throughout southwest Alaska prompted the Alaska Board of Fisheries in November 1997 to reduce the daily bag limit from 10 to 3 char per day throughout the region.

In response to these concerns and to provide more information for developing management strategies, the Togiak National Wildlife Refuge (Refuge) initiated research to investigate the life history and habitat use by Dolly Varden throughout the Refuge (Lisac and Moran 1999, Lisac and Nelle 2000, Reynolds 2000, Lisac and Buchholtz 2001, Crane et al 2003, and Lisac 2004 and 2006). Previously, radio telemetry and visual marking were used successfully to identify important spawning and overwintering areas for, and document life history aspects of anadromous Dolly Varden in the Kanektok River drainage (Lisac 2006).

A weir was established by the Department in 2001 at river km 67.6 to enumerate salmon escapement in the drainage (Estensen and Diesinger 2003). The weir is a floating resistance-board design approximately 76 m in length and is comprised of three major parts: the resistance board panel section, the fixed picket section and the substrate rail (Tobin 1994 and Stewart 2002). The resistance board panel is constructed of 25-mm x 6.1-m PVC schedule 40 pickets laid out on stringers at approximately 16 pickets per 1.2 m panel. The space between the pickets is approximately 43 mm. The design allows the weir to stay operational during periods of moderately high water flow while still preventing most salmon passage upstream. An estimate of the daily and seasonal Dolly Varden passage has also been provided by the weir. In 2001 the weir was operated between 9 August through 3 October and approximately 2,500 Dolly Varden were counted. In 2002 the weir was installed much earlier in the season and operated from 1 July to 20 September, and counted 15,198 Dolly Varden. The daily passage in 2002 ranged from 0 to 2,245 fish a day with 71.7% ( $n = 10,895$ ) of the run passing upstream of the weir during an eleven-day period between 14 and 24 July.

Dolly Varden runs in much of Alaska are composed of stocks of mixed origin and maturity (DeCicco 1985, Whalen 1992, Larson 1997, and Lisac and Nelle 2000). The early component of most Dolly Varden runs is generally comprised of a higher proportion of mature, prespawning fish. This proportion, as well as the size of fish, has been documented to decline as the run progresses. Immature and nonspawning fish dominate the later half of the run and typically enter the river to feed and overwinter. These characteristics make monitoring the annual returns of this species problematic. Other studies have dealt with the problem of providing a meaningful estimate of Dolly Varden abundance in a variety of ways (Whalen 1992 and Larson 1997). Whalen (1992) concluded that monitoring spawner abundance of Dolly Varden would provide a more useful number that could be compared between years and contribute to long-term monitoring. The key element is to estimate the number of spawning, mature fish returning annually to the system. This has been accomplished by apportioning the total estimated Dolly Varden daily counts by a maturity and size index. Based on previous studies (Lisac and Moran 1999, Estensen and Diesinger 2003, Lisac 2004 and 2006), the most important time in which to estimate Dolly Varden spawner abundance is during early July to mid-August.

The Refuge attempted to qualify the Dolly Varden run to estimate the number of prespawning fish passing upstream through the Kanektok River weir based on maturity index proportions of fish caught by beach seining upstream of the weir (Lisac 2006). Of the 5,097 fish counted between 20 July and 3 August 2002 an estimated 55% ( $n = 3,161.5$ ;  $SE = 189.6$ ) mature Dolly Varden passed upstream of the weir. This report builds on the 2002 Dolly Varden investigation, and presents the succeeding studies that took place in 2003 to 2005. The objectives addressed in this report are to: 1) determine the annual run timing of Dolly Varden passing upstream of the Kanektok River weir; 2) estimate the number of prespawning Dolly Varden passing the Kanektok River weir during July mid-August; and, 3) describe the length, sex and maturity structures of the runs of Dolly Varden immigrating past the Kanektok River weir.

## **Study Area**

The Kanektok River drainage lies along the northern boundary of the 4.7 million acre Togiak National Wildlife Refuge in southwest Alaska (Figure 1). The river originates in the Ahklun Mountains in the northeast corner of the Refuge and drains approximately 2,261 km<sup>2</sup> (Walsh et al. 2005). The Kanektok River flows from Kagati and Pegati lakes, elevation 320 meters, and flows west for 146 km to Kuskokwim Bay. Numerous unnamed tributaries feed the lakes. Two

named tributaries, Atmugiak and Akamunak creeks, feed Kagati Lake. River discharge was calculated to be 14.1 cms in July 1983 below the outlet of Kagati Lake. The river width was 70.1 m at the site. The upper portion of the river is a single channel as it flows through mountain valleys. The river emerges from the mountains and flows across a broad alluvial plain composed primarily of gravel substrate where the river becomes braided with multiple side channels. The upper 116 km of the Kanektok River are within the Refuge Wilderness Area while the lower 30 km of river are bordered by Quinhagak Village corporation lands. The Village of Quinhagak is located near the mouth of the Kanektok River at Kuskokwim Bay.

Four major tributaries flow from the south and join the Kanektok River in the uppermost 72 km of the river below Kagati Lake. They are (from lower to uppermost): Takshilik, Nukluk, Klak, and Kanuktik creeks. Several smaller named tributaries flow from the north: Quickumguila, Olumagwilute, Sam, Nakailingak, Amakatatee and Paiyun creeks. Only Kanuktik and Klak creeks have headwater lakes of any significant size.

## **Methods**

Dolly Varden migrating upstream in the Kanektok River were counted at the weir operated by the Department's Commercial Fisheries Management Division. Weir design and operations are outlined by Estensen and Diesinger (2003). Dolly Varden were captured using a live trap attached to the weir and beach seining 5-10 km (3 - 6 mi) upstream of the weir. Sampling efforts were concentrated during the early portion of the run when the proportion of prespawning Dolly Varden is higher (Whalen 1993, Larson 1997, Lisac and Nelle 2000, and Lisac 2004 and 2006).

In 2002 and 2003 no modifications were made to the weir design. The operation of the live trap was modified in two ways during 2004 and 2005. The inside of the trap was lined with a 25mm square mesh material to decrease the gap between the trap pickets preventing smaller Dolly Varden (< 400 mm) from escaping the trap. The trap was also baited using roe obtained from female salmon carcasses that washed downstream onto the weir. In 2002 and 2003 the beach seine used was 30-m x 3-m x 25-mm square mesh material. The beach seine used in 2004 was made of similar material, but was 40-m x 4-m in dimension. No beach seine effort occurred in 2005.

Species confirmation was determined by using external characteristics previously reported in Lisac and Moran (1999). All Dolly Varden captured were measured for fork length to the nearest 1.0 mm. Dolly Varden greater than 250 mm were marked with an individually numbered "T" bar anchor tag to identify individual fish and document any fish movements observed from future recaptures. Sex, color and maturity were recorded for each fish. Mean fork lengths and length frequency distributions (10 mm increment) were determined for prespawning and all Dolly Varden from each annual sample. Mean fork lengths of prespawning fish were compared between and within years using analyses of variance. If the ANOVA test indicated a difference among years, a Fisher's least significant difference multiple range test was used to determine which years were significantly different. Tested differences were considered significant at an alpha level of 0.05.

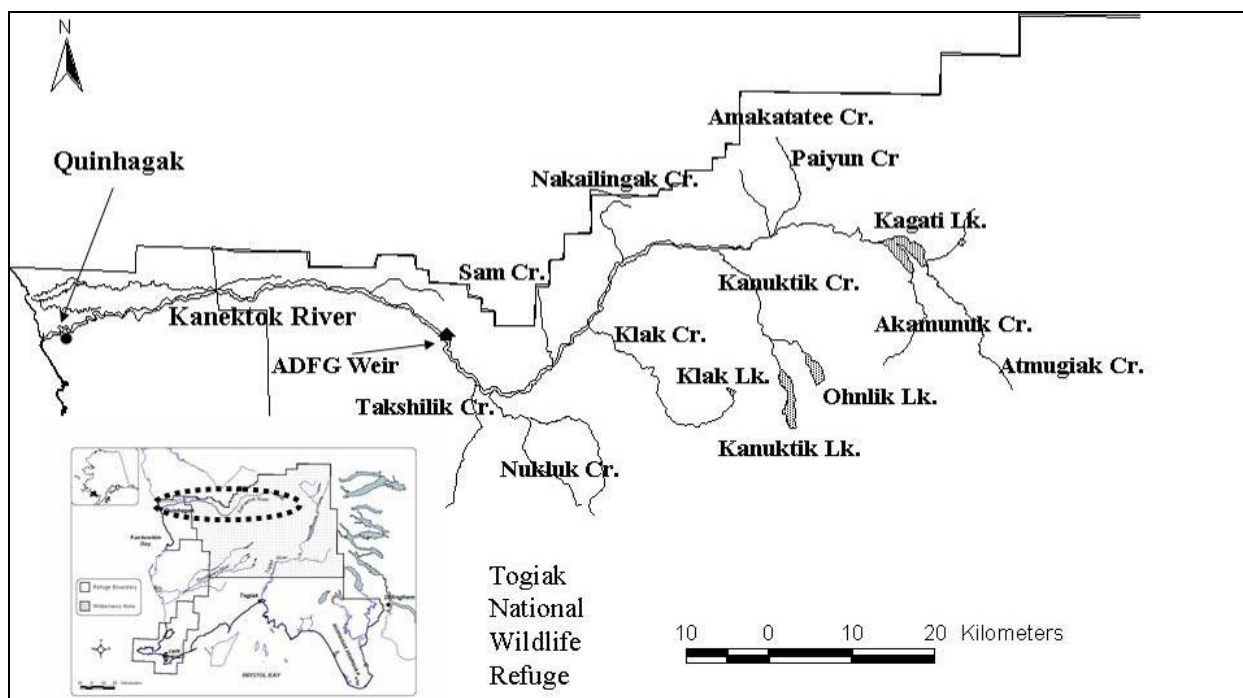


FIGURE 1.—Kanektok River drainage, Togiak National Wildlife Refuge.

A maturity index (Lisac 2006) was used to classify fish as immature, nonspawner, prespawner, potential spawner, or unknown. Photographic keys were used to train all field personnel to identify sex and maturity of fish using external characteristics. The primary external characteristics were the coloration of the body, head, jaw and fins. Fish were characterized as being either 1) silver or showing no color; 2) showing signs of color change (darkening opercle, head and jaws, reddening of fins with white leading edge); or 3) full spawning colors (head shape, kype formation, a swollen ovipositor or abdomen). Dolly Varden were periodically photographed and sacrificed to confirm the maturity index and sex based on gonad development.

The annual sample period was divided into 3 to 4 equal time strata of 7 to 10 day duration. The number of prespawning fish, and their respective variances, were estimated by multiplying the total Dolly Varden weir count for each time strata by the proportions of prespawners for that time strata (Larson 1997 and Lisac 2006). The number of Dolly Varden prespawners passing through the weir was estimated by summing the estimate and variance of each time strata.

Dolly Varden captured by seine were used to estimate prespawner proportions in 2002 and 2003 because the live trap was size selective (Lisac 2006). Modifications to the live trap and capture methods occurred in 2004 and 2005. Dolly Varden captured by both gear types were used in 2004 to estimate prespawner proportions. In 2005 the weir live trap was the only capture method used. The segment of the run that was apportioned included all fish counted through the weir from the first day of weir operation to the last day of our sampling effort. The number of prespawners passing the weir site prior to our arrival was estimated using the proportion of prespawners observed in the first strata.

## Results

The Kanektok River weir was operated by July 1 until the third week of September for three of the previous four years (Table 1). High water levels in 2005 delayed installation of the weir and required an earlier removal. The annual Dolly Varden run past the Kanektok River weir averaged 11,206 fish and ranged between 9,195 (2003) and 15,674 (2002). The earliest run arrival was 26 June (2003) (Table 2; Figure 2 and 3). The average mid-point of the run arrival occurred on 25 July, and ranged between 19 July (2002) and 31 July (2005). The average 50% peak of the run has occurred during a 23-day period between 16 July and 7 August for all years. In 2002, 50% of the run passed the weir during an 8-day period (17 to 24 July) indicating an earlier run timing. The highest recorded daily passage (2,245 fish) occurred on 18 July 2002.

**TABLE 1.—Total run, sample size and estimated prespawning Dolly Varden at the Kanektok River weir, 2002 to 2005.**

	2002	2003	2004	2005
Dates of weir operation	7/01 – 9/20	6/24 – 9/18	6/29 – 9/20	7/08 – 9/08
Total run	15,674	9,195	9,861	10,093
Sample period dates	7/10 - 8/03	7/16 - 8/10	7/10 - 8/22	7/8 - 8/12
Number of fish captured	1,487	485	1,458	399
Number of fish used for apportioning weir counts <sup>1</sup>	1,290	201	1,207	399
Percent prespawners	55.0%	73.6%	72.8%	98.5%
Apportioned dates	7/01 – 8/03	6/26 – 8/10	6/29 – 8/22	7/08 – 8/12
Apportioned weir count	13,684	7,657	8,769	9,221
Estimated prespawners	8,709	5,815	7,130	9,073
SE	588.1	517.8	158.0	106.1

<sup>1</sup> Only days with complete capture information and reliable maturity index assignments were used.

Dolly Varden capture efforts occurred between 8 July and 22 August for all years (Table 1). Annual sample sizes for the combined gear types ranged between 399 (2005) and 1,487 (2002) fish (Tables 3 and Figure 4). Overall mean fork-length ranged from 372.8 mm (SD = 83.80; 2004) to 466.5 mm (SD = 71.76; 2003). The smallest fish sampled was 154 mm (2004), while the largest was 658 mm (2002). Prespawning Dolly Varden ranged in size from 215 mm (2005) to 640 mm (2002) (Table 3).

Mean fork lengths for prespawning fish ranged from 409.2 mm in 2004 to 480.4 mm in 2003 (Table 3). Comparison of mean fork lengths between all years found a significant difference ( $p < 0.001$ ) between all year pairs except one. Mean fork lengths for 2004 and 2005 were similar to each other, and significantly smaller than those for 2002 and 2003 ( $p < 0.05$ ).

**TABLE 2.—Dolly Varden passage at Kanetok River weir showing the mid-point (box) and peak (50%) of the run (shaded area), 2002 - 2005.**

Date	Daily Passage			
	2002	2003	2004	2005
6/24		0		
6/25		0		
6/26		1		
6/27		1		
6/28		5		
6/29		0	2	
6/30		1	12	
7/01	7	1	20	
7/02	18	9	8	
7/03	6	2	15	
7/04	5	17	17	
7/05	12	23	25	
7/06	10	18	81	
7/07	6	7	325	
7/08	21	44	248	65
7/09	53	72	337	267
7/10	128	72	375	292
7/11	177	49	374	137
7/12	543	48	237	126
7/13	418	87	86	93
7/14	551	145	74	100
7/15	993	186	101	91
7/16	700	157	109	201
7/17	1,623	81	94	158
7/18	2,245	116	243	88
7/19	1,071	479	480	7
7/20	893	673	341	329
7/21	431	414	342	322
7/22	848	400	235	266
7/23	771	409	254	295
7/24	770	170	261	450
7/25	271	148	314	239
7/26	178	167	237	194
7/27	253	88	237	242
7/28	128	121	104	402
7/29	94	295	132	187
7/30	175	304	125	322
7/31	242	108	173	477
8/01	154	136	228	330
8/02	90	210	431	386
8/03	263	164	303	189
8/04	109	170	153	410
8/05	48	601	141	394
8/06	24	706	320	236



**TABLE 2.—Dolly Varden passage at Kanetok River weir showing the mid-point (box) and peak (50%) of the run (shaded area), 2002 - 2005. continued.**

8/07	10	305	390	75
8/05	48	601	141	394
8/06	24	706	320	236
8/07	10	305	390	75
8/08	15	367	58	275
8/09	7	361	200	213
8/10	1	209	148	251
8/11	5	37	155	336
8/12	12	80	98	319
8/13	26	30	47	457
8/14	46	21	39	191
8/15	76	2	169	279
8/16	91	13	242	36
8/17	138	23	195	23
8/18	157	18	139	16
8/19	107	18	36	80
8/20	46	18	48	4
8/21	24	30	51	34
8/22	8	59	8	4
8/23	62	52	23	42
8/24	32	57	36	20
8/25	32	51	63	37
8/26	23	38	24	32
8/27	51	19	3	9
8/28	6	20	3	13
8/29	25	58	0	32
8/30	2	122	2	
8/31	15	48	2	
9/01	18	20	4	
9/02	27	10	2	
9/03	5	50	1	
9/04	88	35	0	0
9/05	13	15	4	9
9/06	86	11	2	2
9/07	28	8	3	8
9/08	12	15	9	1
9/09	27	5	8	
9/10	7	14	7	
9/11	2	6	7	
9/12	3	11	2	
9/13	3	10	6	
9/14	0	8	5	
9/15	4	4	1	
9/16	3	3	5	
9/17	1	9	3	
9/18	1		4	
9/19	0		3	
9/20	0		12	
Total	15,674	9,195	9,861	10,093

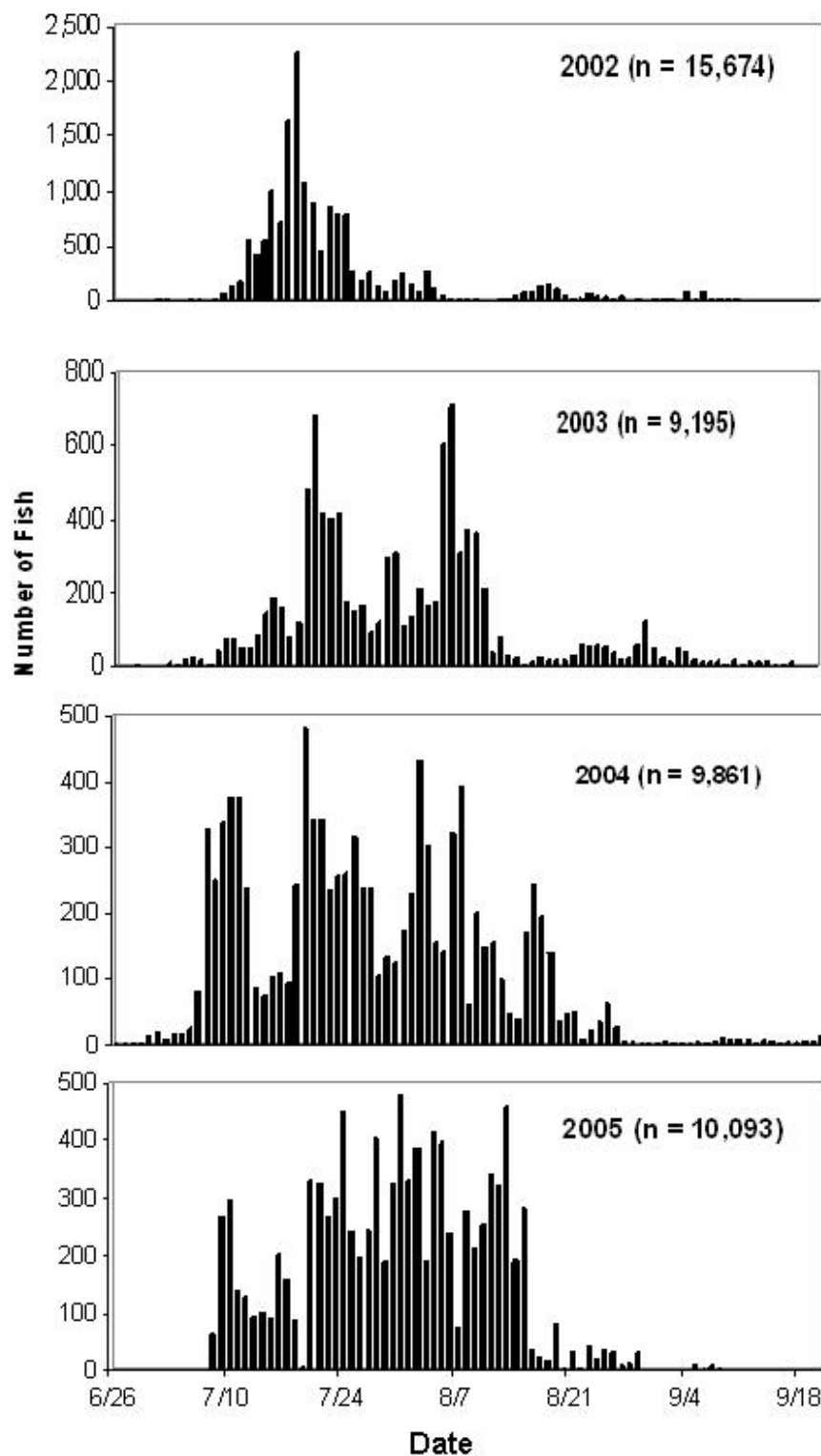


FIGURE 2.—Number of Dolly Varden counted past the Kanektok River weir per day, 2002 - 2005.

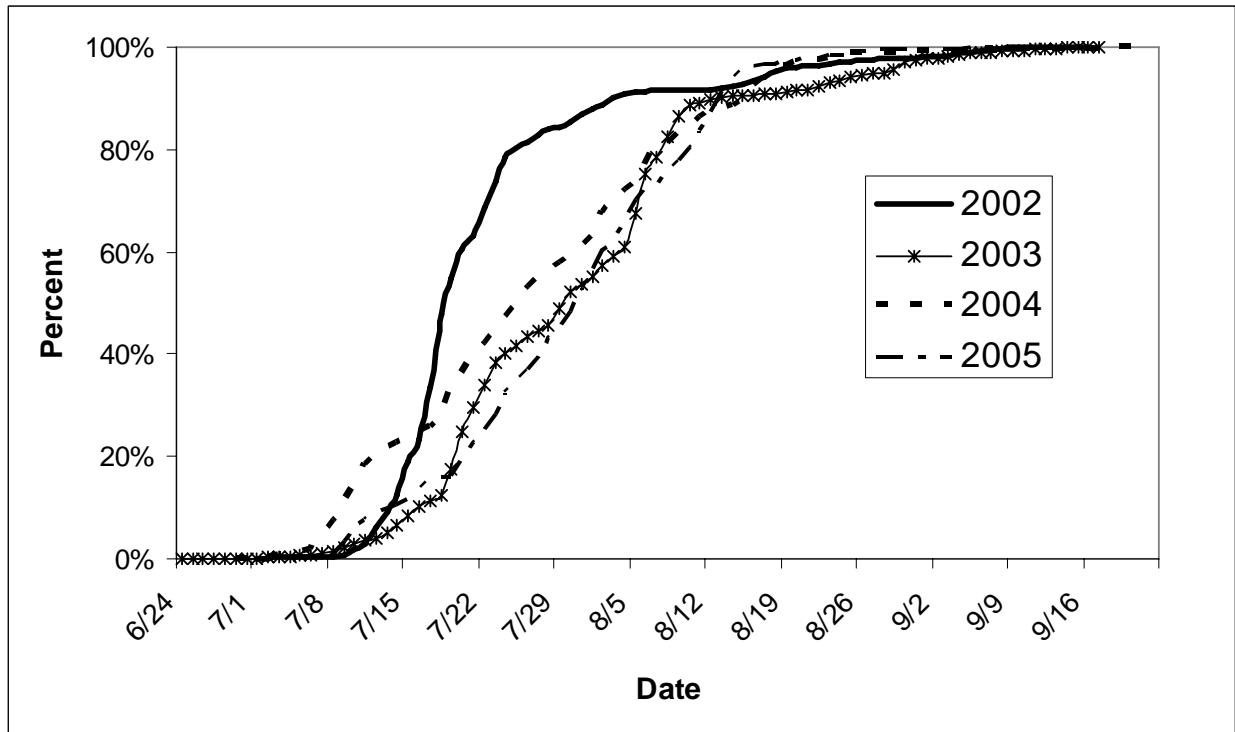
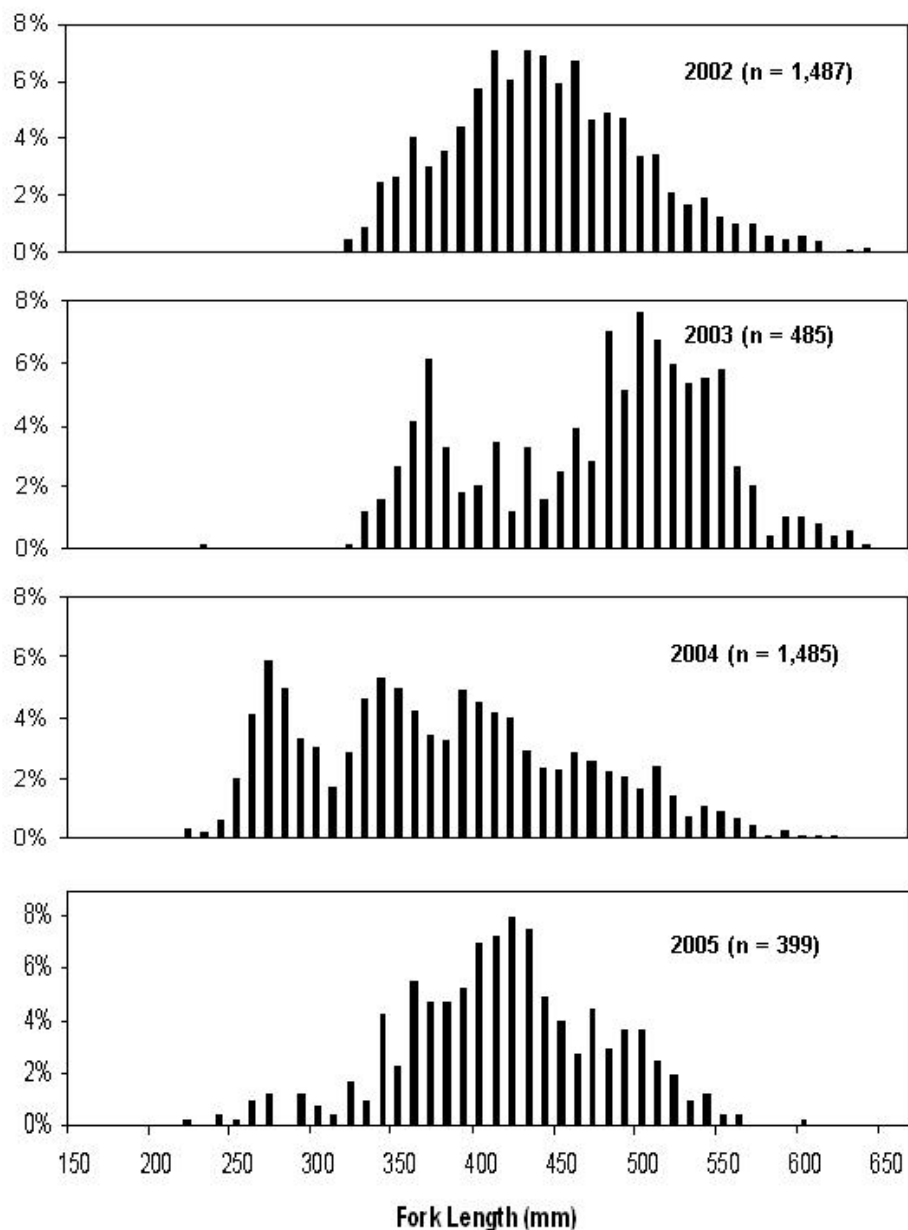


FIGURE 3.—Cumulative run timing for Dolly Varden in the Kanektok River, 2002 to 2005.

TABLE 3.—Mean fork length and size range for Dolly Varden caught at the Kanektok River weir, 2002 - 2005.

	2002	2003	2004	2005
<u>All</u>				
Mean FL	438.7	466.5	372.8	410.6
SD	60.69	71.76	83.80	63.91
Minimum	313	230	154	215
Maximum	658	621	624	600
<i>n</i>	1,487	485	1,458	399
<u>Prespawners</u>				
Mean FL	470.1	480.4	409.2	412.7
S.D.	51.08	62.95	74.24	61.69
Minimum	320	335	216	235
Maximum	640	621	624	600
<i>n</i>	866	428	939	393



**FIGURE 4.**—Fork length frequency distribution for Dolly Varden caught by all gear types in the Kanektok River, 2002 – 2005.

The annual sample size ranged from 2.6% to 13.8% of the total weir counts between 2002 and 2005 (Table 4). The percent of prespawners in a time strata ranged between 23.5% and 100%. The annual number of mature prespawning Dolly Varden in the total weir count was estimated using the proportion of mature fish observed in either the seine sample (2002 and 2003), the weir live trap sample (2005), or both (2004) (Table 4 and Figure 5). An average of 7,500 prespawning Dolly Varden passed upstream of the weir during July and early August between 2002 and 2005. The largest estimated run of prespawning fish ( $n = 9,073$ ) occurred in 2005.

**TABLE 4.—Weir count, sample size and estimated prespawner (PR) of Dolly Varden from the Kaneketok River, 2002 - 2005, by time strata.**

<b>2002</b>	Time strata	Weir count	Number sampled	Percent sampled	Number prespawners	Percent PR in sample	Estimated PR	SE
	1	12,299	480	3.9%	310	64.6%	7,945	585.5
	2	724	216	29.8%	143	66.2%	479	45.6
	3	661	594	89.9%	256	43.1%	285	28.4
	Total	13,684	1,290	9.4%	709	55.0%	8,709	588.0

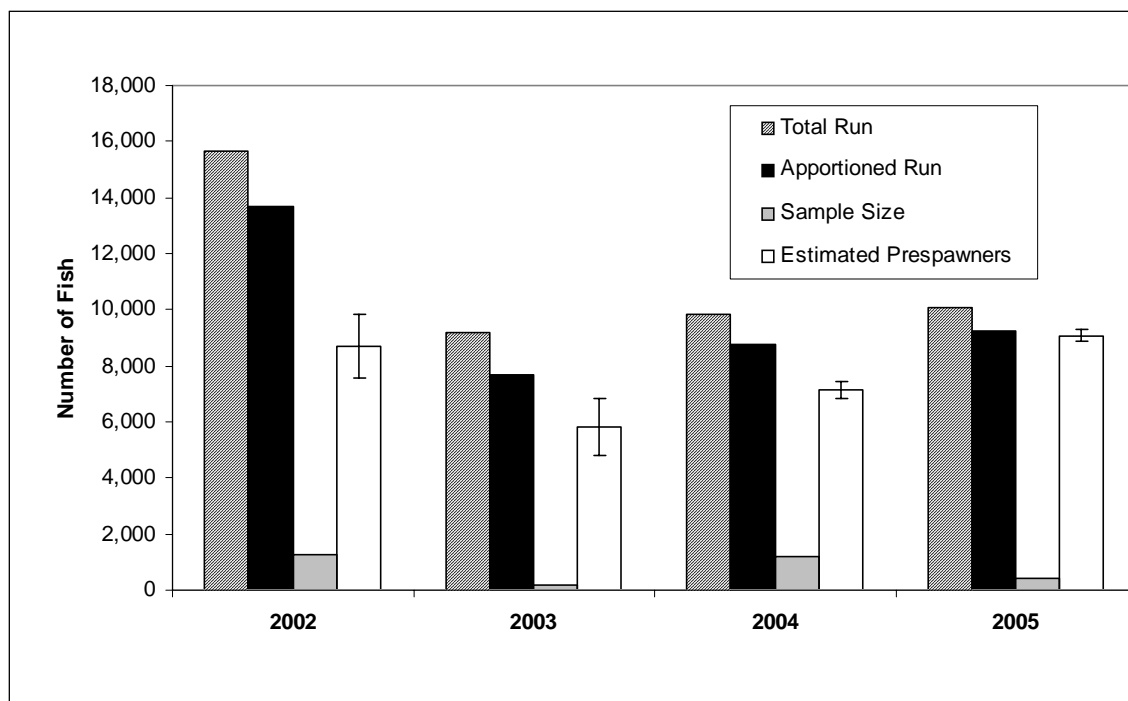
<b>2003</b>	Time strata	Weir count	Number sampled	Percent sampled	Number prespawners	Percent PR in sample	Estimated PR	SE
	1	3,679	49	1.3%	39	79.6%	2,928	424.1
	2	1,429	66	4.6%	43	65.2%	931	183.4
	3	2,549	86	3.4%	66	76.7%	1,956	233.7
	Total	7,657	201	2.6%	148	73.6%	5,815	517.8

<b>2004</b>	Time strata	Weir count	Number sampled	Percent sampled	Number prespawners	Percent PR in sample	Estimated PR	SE
	1	2,540	228	9.0%	221	96.9%	2,462	50.0
	2	2,944	280	9.5%	273	97.5%	2,870	47.1
	3	2,397	516	21.5%	342	66.3%	1,589	100.7
	4	888	183	20.6%	43	23.5%	209	100.4
	Total	8,769	1,207	13.8%	879	72.8%	7,130	158.0

<b>2005</b>	Time strata	Weir count	Number sampled	Percent sampled	Number prespawners	Percent PR in sample	Estimated PR	SE
	1	1,954	79	4.0%	73	92.4%	1,806	106.1
	2	3,396	99	2.9%	99	100.0%	3,396	0.0
	3	3,871	221	5.7%	221	100.0%	3,871	0.0
	Total	9,221	399	4.3%	393	98.5%	9,073	106.1



**FIGURE 5.—Number of Dolly Varden counted at the Kanektok River weir, and estimated prespawner abundance with 96% confidence intervals, 2002 to 2005.**

## Discussion

The weir was installed and operational in a timely manner to capture the onset of the Dolly Varden run for three of the four study years. The fish generally reached the weir location by the first of July and continue to pass throughout September. Daily Dolly Varden passage prior to July 1 was minimal for the three years when the weir was operational in June. In 2005, high water delayed installation of the weir until July 8, and 65 Dolly Varden were counted on that day.

The annual returns of Dolly Varden to this system were similar in three of the four years in terms of magnitude (mean = 9,716, S.E. = 466). However, the magnitude and run timing observed in 2002 was quite different than that observed in the more recent years. The run was compressed and was 50% greater than the other three years.

The run-timing and ASL composition of Dolly Varden is difficult to determine because the Kanektok River weir was designed to enumerate salmon. Determining sexual maturity using non-lethal methods is also difficult. Determining sex and maturity requires stringent training and application of the study protocols. This is especially true when examining female Dolly Varden which do not exhibit the striking coloration of a male prespawner and are more subtle in their development. In two of the four years the proportion of prespawners was approximately 73%. The lower proportion observed in 2002 (55%) could be the result of the late start in the seining effort (20 July) or a greater number of immature fish in the strong run experienced that year. The high proportion of prespawners and smaller mean fork length of prespawners observed in 2005 could be the result of an inexperienced crew inconsistently assigning maturity and not adequately comparing gonad development to external characteristics.

This study approach provided a low cost means of estimating the number of prespawning Dolly Varden in the Kanektok River. Other than in 2002, when a four-person crew was on site and dedicated to capturing Dolly Varden, the work in all other years was conducted with cooperation of Department personnel and additional staffing provided by the Coastal Villages Region Fund. Continued modifications to the weir live trap and the use of bait has improved the success of this method to capture Dolly Varden in greater numbers and size ranges. The importance of accurately assigning maturity indices needs to be stressed and can be improved with better training and supervision. A more rigorous sampling design will be necessary to determine if this sampling method truly represents the daily weir passage.

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